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Models and Computer Applications in Strategic Human Resource Management

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ABSTRACT

The basic premise of this paper is that more adequate and appropriate personal computer (PC) software programs for human resource policy analysis and decision making are needed. In most organizations, PC software programs for these purposes are either nonexistent or oversimplified. An approach to closing this gap is suggested. Three types of quantitative models, which represent the key elements of a fairly wide range of human resource policy analysis and decision making issues, are described. For each model, an illustrative PC software program using Lotus 1,2,3 is demonstrated.

INTRODUCTION

The personal computer (PC), as one component of the age of information technology, has considerably increased the ability of the human resource decision maker to collect, retrieve, and analyze a great deal of human resource information. It seems, however, that PC software programs for supporting human resource decisions in organizations are generally either nonexistent or oversimplified. They are nonexistent in small organizations because small organizations cannot afford to purchase, modify, and maintain the software programs typically developed by commercial vendors for large organizations. They are oversimplified in large organizations because the software programs in place in those organizations have been purchased from commercial vendors and, therefore, are not tailored to meet the special human resource needs of the organization or specific enough to aid decision making in such important activity areas as recruitment, selection, performance appraisal, compensation, and labor-management relations.

Human resource decisions in organizations are usually made and implemented within a broad set of human resource objectives and policies. They are also associated with certain short-term and longer-term costs, which are probably being monitored more closely today than ever before. In fact, the newer strategic emphasis within the human resource field is based on the premise that the human resource function can and should make a cost-effective contribution to the strategic business plans of the organization.

It is difficult, of course, to determine the cost-effectiveness of many human resource activities. It can become a very subjective

matter. How cost effective, for example, are those human resource activities which seek to implement a policy of nondiscriminatory employment? Some organizations have learned that short-term cost savings in this area can be terribly expensive in the longer-term. But without adequate information, a search for any alternative course of action that might enable the decision maker and the organization to reduce human resource costs and improve the organization's overall performance are often meaningless and costly in themselves.

In undertaking the project described in this paper, we had a three-fold purpose. First, we wanted to develop some PC software programs in the human resource field for instructional, classroom use with undergraduate and graduate students interested in human resource careers. An earlier investigation led us to the conclusion that the software programs that were available were essentially too costly and cumbersome and often did not address what we felt were the critical decision issues in the field. Second, we wanted to demonstrate, as part of our instructional efforts, the potential use of the PC in human resource decision making. Third, we wanted to encourage the continuing use of the PC by our students in their human resource careers and perhaps increase as well their skills in designing problem-oriented PC software programs.

Our first task was to select several different quantitative models around which a number of PC software programs could be organized and developed. Three different types of models were selected: human resource planning models, utility models, and costing models. While other models might have been selected by us, it seemed to us that

these three models represented the key elements of a fairly wide range of decisions typically made in the human resource field. An illustrative, problem-oriented PC software program was then developed for each model-type. We included, again for illustrative purposes only, a discrete database in some of the programs. In many larger organizations, a PC to mainframe network might already exist for retrieving a variety of human resource data segments for PC analysis.

There are four additional sections in this paper. In each of the next three sections, we seek first to provide a brief overview of one of the three model-types noted above and then to describe in some detail an illustrative PC software program for that model-type. Additional programs for each model-type, of course, could be developed--and have been developed by us--to investigate a somewhat different decision issue. We attempt in the fourth section of the paper to summarize our project and present a few concluding remarks and suggestions for the future.

HUMAN RESOURCE PLANNING MODELS

Human resource planning is concerned with the aggregate flows of people into, through, and out of organizations, and, at the individual level, with the achievement of the most desirable person-job match possible (Rowland and Ferris, 1982). Inappropriate or shifting policies and budget decisions can make the development and implementation of an integrated human resource plan a difficult task. What is needed is a procedure for relating employment flows to human resource requirements within a set of budget constraints. The availability of

such a procedure should enable the human resource planner to better control the consequences of his or her human resource decisions.

We focus here on the aggregate planning problem versus the person-job match problem. The aggregate planning problem requires the decision maker's response to the organization's changing demand for human resources over time. Specifically, given a forecasted human resource demand, the human resource planner is concerned with the workforce levels needed to meet that demand based on human resource flows and availabilities. Some of the statistical techniques used to forecast demand are regression analysis, productivity ratios, personnel ratios, and time-series analysis (Dyer, 1982). Statistical techniques used to determine human resource flows and availabilities include Markov analysis, renewal analysis, and goal programming. The planning model we present is a simplified, PC-oriented version of a more complex human resource planning model. The more complex model is concerned with optimization, by means of linear programming, of an objective function composed of the costs associated with the number of hires and layoffs, deviations from human resource requirements, deviations from EEO goals, deviations from historical promotion and demotion rates, and deviations from affirmative action goals (Paratje, 1983).

The PC software code developed and discussed here is based on the solution of a set of simultaneous equations for three occupational levels and allows for the selection of a planning horizon between one and ten years. An important element in planning is the evaluation of alternative policies and policy-driven activities. Studies of this nature should be of particular importance in EEO planning.

An index function, modeled after the objective function in the linear programming planning model, is shown in Table 1.1 and is used

Insert Table 1.1 about here

as a benchmark for comparing the effects of different workforce planning policies and activities. Holt, Modigliani, and Simon (1955) have described the classic case in which the terms of the objective function (costs) are found to be nonlinear (quadratic) in nature. On this basis, the index function can be written as a sum of quadratic terms representing deviations from human resource policy objectives. The coefficients of the terms of the index function are not real costs, but different priority weights given to each term according to the policy that is being reviewed. Policy changes can be made by changing the different priority weights given to each term. In this way, we can think of the index function as a penalty function. The goal is to minimize as much as possible the weighted deviations from targeted human resource objectives. In this condition, the deviations are accorded relative weights, which reflect priorities associated with being over or under on each term of the model. These relative weights, which replace the dollar-cost figures normally associated with conventional models, can be considered a "priority cost" for each term, where the highest relative cost is associated with the most critical term.

Internal workforce dynamics include both movement within and out of the organization. Losses to the organization may be subdivided further into losses from people retiring or terminating for reasons

other than retirement. These internal flows of people (promotions, demotions, external hires and layoffs, retirements and terminations) are incorporated into the model by means of the concept of transition matrices. A transition matrix depicts the percentages of transitions among job categories and can be obtained from past organizational data. For our case, the transition matrix structure is illustrated in Table 1.2, with retirement and termination being the only two absorbing

Insert Table 1.2 about here

states (no exit from these states is allowed). The definition of promotion to the state j will be the movement to this state from the preceding state(s) i. As such, all promotions to category i will be zero because no preceding state exists that can be considered a pool of people for that state. The definition of demotion to state j is the movement to this state from the following state(s) i. Again, demotions to the last occupational level will be zero because of the definition of demotion. In every occupational level (state) of the model, the basic rule that must hold is that the sum of the percentages of persons entering or quitting the state at a given observation period must equal one.

The decision maker must provide the program with the historical transition rates between occupational categories or with an estimate of future rates, either as an indication that the historical rates will be maintained or as a set of anticipated or desired transition rates. An independent forecast of the demand for the product or service of the company will provide the human resource planner with the

human resource needs for the next period or periods in the form of a rate of growth (or decline). Total workforce levels at the base year, and their breakdown into occupational levels, are required inputs to the program.

The output of the program matches the total workforce requirements for the individual years of the planning period with the attrition levels given by the previous workforce levels and the transition rates. An insufficient number of employees in a given planning year will result in an external hiring need. The opposite problem may result in layoffs. By assigning priority costs to each of those actions, a set of planning policies can be established that minimizes the index value.

In the software illustration, various alternative policies regarding potentially different sets of employment characteristics are examined. These employment characteristics include an organization that is not engaging in discriminatory practices and an organization that has been pursuing such practices in the past and is investigating possible alternative policies for redressing the results of those practices. The forecasted human resource needs will be kept the same for both organizations in order to allow for a comparison of the results. We define a non-discriminatory organization as one in which the ratios of men and women by occupational category in the organization are comparable to those in the labor market and the historical rates of promotion for both sexes are equal. By contrast, we define a discriminatory organization as one in which past policies have resulted in significant differences between the ratios of men and

women by occupational category in the organization and in the labor market. A redressing of the situation is possible by an emphasis on the accomplishment of EEO goals and by means of an active affirmative action program.

Human resource flow patterns for the non-discriminatory organization are presented in Tables 1.3 through 1.5. We observe that in a

Insert Tables 1.3 through 1.5 about here

non-discriminatory environment, the model can be utilized to forecast human resource needs and satisfy EEO concerns. Human resource flows for the discriminatory organization are presented in Tables 1.6 and 1.7. A redressing of the discriminatory situation is sought through

Insert Tables 1.6 and 1.7 about here

strict application of EEO policies. The results of a policy to increase the promotion rates of females are shown in Table 1.7. By the planning year 1988, a redressing of the former male to female imbalance is corrected.

UTILITY MODELS

Since the costs associated with the human resource function are becoming increasingly a larger portion of the overall costs of many organizations, investments in human resource programs will have to be justified in the same way as other investments. As this trend continues, pressures will develop to seek and achieve cost efficiencies in existing and new human resource programs. In this context, it is likely that utility analysis, along with other decision support

approaches, will play a greater role in helping human resource managers and specialists make decisions that contribute to the organization's "bottom line," as well as the accomplishment of the organization's longer-term strategic goals.

In regard to personnel selection, Cascio (1982) has defined the utility of a selection device as "the degree to which its use improves the quality of the individuals selected beyond what would have occurred had that device not been used" (p. 130). Quality here is regarded as either (1) the proportion of individuals in the selected group who are considered successful, (2) the average standard score on some job performance criterion for the selected group, or (3) the dollar payoff to the organization resulting from the use of that device. Because the term "device" suggests to us a single selection instrument, we will henceforth use the term "procedure" to connote the possible combination of two or more instruments, as in a test battery.

The history of the application of utility concepts to human resource decisions started with classical testing theory, in which the utility of a selection procedure was assessed in terms of its accuracy in measuring some attribute or set of attributes on a continuous scale or scales. The best known utility models are those of Taylor and Russell (1939), Naylor and Shine (1965), Brogden (1946, 1949), and Cronbach and Gleser (1965). A brief review of these models follows.

Taylor and Russell (1939) developed a utility model in which the overall utility of a selection procedure is a function of three parameters: (1) the validity coefficient, defined as the correlation between a predictor of job performance and a criterion measure of actual

job performance; (2) the selection ratio, defined as the proportion of applicants hired, and; (3) the base rate, defined as the proportion of applicants who would be successful in the job if the selection procedure was not used. The disadvantages of this approach are the requirement that the criterion be dichotomous, resulting in a group of satisfactory and a group of unsatisfactory employees. Furthermore, in many situations, the decision of the cutoff point between satisfactory and unsatisfactory performance among employees is an arbitrary one. It follows that for a given validity, the use of a low selection ratio should be advocated (i.e., select only the best). If carried to the extreme, however, recruitment efforts would have to be expanded beyond an appropriate level.

Brogden (1946, 1949) demonstrated the relationship between the costs of selection, validity, selection ratio, and utility. Job performance is quantified as a dollar figure. His approach allows the calculation of the mean gain in productivity per selectee (expressed in dollars) of the selection procedure when compared to random selection. Brodgen's approach demonstrated the importance of the standard deviation in job performance in affecting the utility of a selection procedure. He concluded that a selection procedure with low validity can still produce positive payoffs if the selection ratio is also low. Conversely, if the selection ratio is high (all applicants are hired), even selection procedures with high validity are useless since their payoffs are negative. This restriction, which the Taylor-Russell tables do not address, was taken into account by Brogden.

Cronbach and Gleser (1965) extended the general approach of Brogden to a more complex approach to human resource decision making. Cronbach and Gleser argued that selection procedures should be analyzed on the basis of their incremental contribution over the strategies available before. New procedures must demonstrate positive incremental utility before their adoption. Their formulation is directed toward assessing utility in terms of mean gain in productivity per applicant. They also incorporated the costs of selection and of gathering information into their utility estimates. Cronbach and Gleser demonstrated that the net gain in utility U, from testing N persons in fixed treatment selection is:

$$U = N \cdot SD_e \cdot r_{ye} \cdot \lambda(y') - N \cdot C_y$$

where, C_y is the cost of testing one person, r_{ye} is the correlation of the selection procedure with the criterion in the a priori population, SD_e is the standard deviation of this criterion, y' is the cutoff score on the selection procedure, and $\lambda(y')$ is the ordinate of the normal curve at that point.

This approach is most appropriate in those cases in which a meaningful representation of the criterion performance can be shown in dollars, and also where linear regression of the criterion on the predictor can be assumed. The approach also provides a more accurate estimate of utility than that provided by the Taylor-Russell method, since no decision must be made concerning the dichotomization of the criterion measure.

The model that has been implemented by us for use with a PC is the Cronbach and Gleser general utility model. It is applied here to allow direct dollar-cost comparisons between the use of a traditional selection procedure (i.e., a procedure currently in use) and a proposed alternate assessment center procedure. Upon loading of the program, the user is confronted with some questions regarding the general characteristics of the comparison to be made; in this case, between the two mutually exclusive selection procedures: a traditional procedure and an assessment center procedure. Input information to the program, as shown in Table 2.1, includes the quota for

Insert Table 2.1 about here

selection (defined as the number of successful managers desired), the standard deviation of the criterion as a dollar figure, the average years of tenure in the position for which the selection procedure is to be used, the average stability of incumbent performance from year-to-year, and the proposed alternative selection procedure (as a variant to the traditional procedure). The relevant cost information, as illustrated in Table 2.2, is composed of four items: recruitment

Insert Table 2.2 about here

costs (internal and external), induction costs, training costs, and selection costs. Selection costs are further subdivided into two related costs, the costs of the traditional selection procedure and the costs of the alternate selection procedure being examined. A feature of the program allows the use of a single dollar figure per

candidate under the proposed alternate selection procedure to represent the cost of the procedure, if no breakdown by categories is available.

The number of candidates to be screened under each of the two selection procedures depends on the selection ratio. The software allows the use of a different selection ratio for the traditional procedure and the alternate procedure. The selection ratios can take values from .01 to .99, with increments of .01. Since the candidates can be selected from either internal or external sources, the program allows for a breakdown by origin of the candidates. This breakdown is then applied in the calculation of the total cost for each procedure.

Once the selection ratios have been determined, the ordinates of the ratios selected are automatically determined, based on the Naylor and Shine tables, which are an integral part of the software program. Different validities can be assigned for the traditional and alternate selection procedures. The program will accept validity values between .01 and .99, with increments of .01. This feature provides for complete flexibility in the comparison of the two selection procedures.

The output information of the software program is presented in Table 2.3 as the incremental gain in utility provided by the left-hand

Insert Table 2.3 about here

term in the general Cronbach and Gleser utility equation. The total cost figure shown for each selection procedure corresponds to the right-hand term in the general utility equation and permits the

calculation of the gain in utility under each procedure (i.e., the difference between the incremental gain and total cost).

The payoff of the selection procedure under consideration is the difference between the gain in utility obtained for that procedure and the gain in utility of the traditional selection procedure over random selection. The program also provides a payoff for the alternate procedure as a function of the number of persons selected (see Table 2.3). Positive payoffs are associated with worthwhile investments, since they represent cost-efficient procedures.

Following Cascio (1982), a numerical example is presented in Figure 2.1, where the relationships between the criterion and standard

Insert Figure 2.1 about here

deviation, the assessment center payoff per selectee, and the assessment center validity can be examined. Assuming a traditional selection validity of .20 and a selection ratio for both procedures of .50, we observe that at high standard deviations of the criterion, the payoff from using an assessment center is higher than at lower standard deviations. If we allow the assessment center validity to change, we observe that, in all cases, a positive payoff is present when the validity of the assessment center procedure is higher than the validity of the traditional selection procedure.

The relationships between the assessment center payoff per selectee, the standard deviation of the criterion and the assessment center selection ratio can be examined from the data displayed in Figure 2.2.

Insert Figure 2.2 about here

In this case, we observe a decreasing assessment center payoff as the selection ratio increases. The larger payoffs occur at higher values of the standard deviation of the criterion for a given validity of the assessment center procedure. This result stems from the fact that increasing the selection ratio represents a less selective policy for the organization, and hence lowers utility. The effects on the assessment center payoff of the assessor-to-assessee ratio and the number of assesses per assessment center are negligible. Also, the effects of increased costs on the assessment center payoff are small, and, for a wide range of costs, the curve relating total costs to assessment center payoff would be slightly downward sloping.

The last relationships that can be examined are those presented in Figure 2.3, between the gain in utility of the assessment center pro-

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Insert Figure 2.3 about here

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cedure and the gain in utility of the traditional selection procedure at different validities and for two different, extreme, standard deviations of the criterion. We observe that selection devices with low validity may yield positive gains in utility if the standard deviation of the criterion is large. On the other hand, if the standard deviation is small, selection devices with high validity result in less gain in utility.

COST ANALYSIS MODELS

Historically, accounting techniques for planning and control arose in conjunction with manufacturing activities, rather than nonmanufacturing activities, because the measurement problems were less imposing and environmental factors were generally less influential. However, some form of cost accounting is applicable to all organizations, regardless of the extent of the measurement problems, the effect of environmental factors, and finally, whether or not they are operated for profit or not-for-profit goals.

A clear relationship exists between cost accounting information and management decisions. The general approach to the accounting of human resource activities that we utilize is one of cost-benefit; that is, the primary criterion for choosing among alternative activities or programs is how well, in relation to their costs, they contribute to the achievement of organizational goals. The intent of this section of the paper is to examine some important areas in human resource costing, to identify the relevant cost elements, and to show how they may be utilized to yield valid cost estimates through the application of an appropriate PC software code. Most organizations have costs that can be classified as either variable or fixed. A fixed cost is fixed only in relationship to a given time period and a given range of activity. An example of a fixed cost would be the salary and fringe benefits of the replacement of a grievant employee who is not working when involved in the grievance meetings. A variable cost changes in direct proportion to changes in activity. An example of a variable cost would be the overtime cost incurred because of absenteeism.

Virtually every area in the human resource field is potentially subject to this sort of cost analysis. We will focus our analysis here on the management of grievances by presenting a PC software program that analyzes grievance costs. The program combines an internal database containing the records of all grievances filed with the elements of a cost-analysis model. In this format, the user can conduct either an analysis of the costs of the grievance stored in the database or determine the costs associated with different courses of action in processing the grievances still pending. The program is completely menu driven and provides the possibility of designing and printing relevant graphics. In the next several paragraphs, we review the program and its different modules.

The main menu of the program provides the user with a choice between conducting an analysis of the data, creating graphics, printing the results obtained, or saving the work done. Information concerning the main menu is contained in Table 3.1 Each of the main menu items

Insert Table 3.1 about here

presents the user with a set of secondary menus. Movement within the program can be accomplished through the selection of the appropriate menu item. To gain further insight into the nature of the program, let us consider the case of XYZ Company, a hypothetical company that uses this program for tracking and costing employee grievances. XYZ Company has kept a record of all grievances filed in 1985 in the program's database. During the month of November, two new grievances were filed: the first one involves a technician from Department A and

can be categorized as Issue 1; the second one involves two grievants from Department H, their supervisor Mr. Smith, and can be categorized as Issue 2.

A straightforward database update is available by selecting ANALYSIS from the main menu and then the DATABASE option. This positions the program in the database region of the worksheet and the user is able to enter the new information into the database.

A human resource decision maker probably would be interested at this point in developing an appropriate course of action to deal with the two grievances. One possible approach would be to consider the dollar costs and the values of the informational inputs used and incorporate them into a decision tree structure, as illustrated in Figure 3.1, to create a dollar estimate of the expected costs of

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Insert Figure 3.1 about here

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settling the grievances. Five payoffs corresponding to the five possible solution points of the grievance process are shown in Figure 3.1. Each solution step involves a payoff dependent on the settlement costs, the people involved in the negotiations at the solution step, the time required to settle the grievance, and the time used in the previous steps in which a settlement was not obtained. The user is required to decide on the subjective estimates of the probabilities of a solution at each subsequent step of the grievance procedure, and the time that would be required to settle or that would be used if no settlement was achieved.

A numerical example may help to illustrate the process. Let us consider the grievance of the technician from Department A. The process begins with the selection of ANALYSIS from the main menu, and UNSOLVED from the secondary menu. A prompt will then appear for the specification of a criterion for selecting a given record from the database, and for the estimates of the probabilities of solution, settlement costs, and time invested. The program output is the expected costs of the solution of this grievance and the payoffs expected at each solution step. Since the program provides for interactive use and modification of different alternatives, two solution packages are provided for this particular example. They are shown in Tables 3.2 and 3.3. The first solution package assumes that

Insert Tables 3.2 and 3.3 about here

the settlement costs are going to be smaller if the grievance is allowed to proceed until solution by arbitration and the probability of solution will remain unchanged over time. The second solution package follows the opposite assumption; that the settlement costs will be increasing as we postpone the solution to arbitration and the probability of solution will increase with time.

Two possible decision rules could be considered when designing solution packages: (1) the best package is the package with the lowest expected total cost, or (2) the best package is the package with the smallest dispersion of costs, to insure that real costs meet certain dollar limits. Using the second decision rule in the above example, we would select the first solution package as the starting

position for our negotiations since it is the one with the lowest dispersion of possible costs.

The second block of functions provided by the program allows the calculation of the costs of the grievances filed. Again, the program allows the user to specify the criterion by which the grievances will be selected from the database and the costs calculated. The value of this feature is that it permits the development of reports targeted to specific groups or individuals, since the selected criterion can be either a department, a supervisor, a given issue, the solution step, or the month in which the grievances were filed. To illustrate, let us calculate the costs of all grievances filed during the month of October at XYZ Company. From the main menu, we would select ANALYSIS and from the secondary menu, COSTS. Required inputs to the program are identified in Table 3.4. As required inputs to the program, the

Insert Table 3.4 about here

user must provide a company-wide estimate of the average wages for the people involved in the grievance process at each solution step: the grievant, the steward, the grievant's supervisor, the utility person (temporary replacement for the grievant), the plant manager, an additional committee person, the director of industrial relations, the union's business representative, the secretary of the committee, and the arbitrator. The program output, as shown in Table 3.4, provides a detailed breakdown of the average costs by solution step and makes the distinction between the negotiation and settlement components of the total costs of the grievances.

The creation of a monthly report would be incomplete without the graphics capability of the program and without the possibility of extracting particular records from the database. The latter can be achieved with the use of the STATISTICS function from the secondary menu on the program. Graphics are created by selecting the GRAPHICS option in the main menu and then specifying the type of graph desired. Examples of the versatility of the graphics capability are presented in Figures 3.2 and 3.3.

Insert Figures 3.2 and 3.3 about here

SUMMARY AND CONCLUSIONS

We have attempted in this paper to propose and demonstrate some potential solutions to the concerns we expressed earlier regarding the often inadequate and inappropriate use of the PC and PC software programs in human resource decision making. We believe that much more needs to be done and can be done in this regard, especially if human resource managers want their function to remain proactive and organizationally productive. At this point in time, it appears to us that we are generally in a condition of underutilization rather than over-utilization.

We are certain that more human resource managers will have PCs in their offices and departments in the years ahead. Even with more PCs, however, we do not wish to advocate an across-the-board, bandwagon-type of response to the use of PC software programs for all human resource decisions. In the exploration of possible cost efficiencies,

the basic question of when and how to use or better use available technology still remains.

Finally, we do not believe that the use of PC software programs and their informational outputs will ever eliminate the need for the thoughtful judgment of the human resource decision maker in generating and utilizing those outputs.

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INDEX FUNCTION

$$C_1 \sum_{i=1}^{3} [H_m(t,i) + H_f(t,i)]^2 + C_2 \sum_{i=1}^{3} [L_m(t,i) + L_f(t,i)]^2 + C_3 \sum_{i=1}^{3} [W_m(t,i) - EEO_m(t$$

$$+ C_4 \sum_{i=1}^{3} [W_f(t,i) - EEO_f(t,i)]^2 + C_5 \sum_{i=1}^{3} [P(t,i) - P^*(t,i)]^2 + C_6 \sum_{i=1}^{3} [D(t,i) - D^*(t,i)$$

PROMOTIONS

$$P(t,1) = 0$$

$$P(t,2) = am_{12} W_m(t-1,1) + af_{12} W_f(t-1,1)$$

$$P(t,3) = am_{13} W_m(t-1,1) + am_{23} W_m(t-1,2) + af_{13} W_f(t-1,1) + af_{23} W_f(t-1,2)$$

DEMOTIONS

$$D(t,1) = am_{21} W_m(t-1,2) + am_{31} W_m(t-1,3) + af_{21} W_f(t-1,2) + af_{31} W_f(t-1,3)$$

$$D(t,2) = am_{32} W_m(t-1,3) + af_{32} W_f(t-1,3)$$

$$D(t,1) = 0$$

EXITS

$$E(t,1) = (am_{1R} + am_{1T}) W_m(t-1,1) + (af_{1R} + af_{1T}) W_f(t-1,1)$$

$$E(t,2) = (am_{2R} + am_{2T}) W_m(t-1,2) + (af_{2R} + af_{2T}) W_f(t-1,2)$$

$$E(t,3) = (am_{3R} + am_{3T}) W_m(t-1,3) + (af_{3R} + af_{3T}) W_f(t-1,3)$$

EXTERNAL HIRES AND LAYOFFS

$$W_m(t,1) = am_{11} W_m(t-1,1) + am_{21} W_m(t-1,2) + am_{31} W_m(t-1,3) + H_m(t,1) - L_m(t,1)$$

$$W_m(t,2) = am_{12} W_m(t-1,1) + am_{22} W_m(t-1,2) + am_{32} W_m(t-1,3) + H_m(t,2) - L_m(t,2)$$

$$W_m(t,3) = am_{13} W_m(t-1,1) + am_{23} W_m(t-1,2) + am_{33} W_m(t-1,3) + H_m(t,3) - L_m(t,3)$$

$$W_f(t,1) = af_{11} W_f(t-1,1) + af_{21} W_f(t-1,2) + af_{31} W_f(t-1,3) + H_f(t,1) - L_f(t,1)$$

$$W_f(t,2) = af_{12} W_f(t-1,1) + af_{22} W_f(t-1,2) + af_{32} W_f(t-1,3) + H_f(t,2) - L_f(t,2)$$

$$W_f(t,3) = af_{13} W_f(t-1,1) + af_{23} W_f(t-1,2) + af_{33} W_f(t-1,3) + H_f(t,3) - L_f(t,3)$$

Table 1.1 Index Function and Simultaneous Equation Model. H(t,i), L(ti), P(t,i), D(t,i), E(t,i), W(t,i) indicate the number of hires, layoffs, promotions, demotions, exits from the system and workforce of the ith occupational level at time t. Subindexes indicate male/female and historical data is denoted by *.

	TO	MALES 1	2	3	FEMALES 1	2	3	RETIREMENT R	TERMINATION T
FROM									
M	1	am_{11}	am_{12}	am_{13}	0	0	0	am_{1R}	am_{1T}
	2	am_{21}	am_{22}	am_{23}	0	0	0	am_{2R}	am_{2T}
	3	am_{31}	am_{32}	am_{33}	0	0	0	am_{3R}	am_{3T}
F	1	0	0	0	af_{11}	af_{12}	af_{13}	af_{1R}	af_{1T}
	2	0	0	0	af_{21}	af_{22}	af_{23}	af_{2R}	af_{2T}
	3	0	0	0	af_{31}	af_{32}	af_{33}	af_{3R}	af_{3T}
R		0	0	0	0	0	0	1	0
T		0	0	0	0	0	0	0	1

Table 1.2 Transition Matrix Structure for a Model With Three Occupational Levels.

INDEX FUNCTION			48,250	57,408	52,995
YEAR		1985	1986	1987	1988
TOTAL WORKFORCE (# persons)		700	770	809	809
GROWTH RATE OF WORKFORCE		10.00%	5.00%	0.00%	0.00%
BREAKDOWN:					
Occupational Level I Males		300	330	347	347
Females		100	110	116	116
Occupational Level II Males		150	165	174	174
Females		50	55	58	57
Occupational Level III Males		80	86	89	88
Females		20	24	27	28
Coefficients: Hires			1	1	1
Layoffs			1	1	1
EEO Males			100	100	100
EEO Females			100	100	100
Promotions			100	100	100
Demotions			100	100	100
	Labor Market Ratios				
EEO Goal Males I		0.75	330	347	347
II		0.75	165	173	174
III		0.80	88	93	93
EEO Goal Females I		0.25	110	116	116
II		0.25	55	58	58
III		0.20	22	23	23
Historical Promotions II			60	60	64
III			40	40	42
Historical Demotions I			25	25	27
II			5	5	5

Table 1.3 Non-discriminatory Organization. EEO Goals and Summary Screen.

YEAR	1985	1986	1987	1988
TRANSITION RATIOS: MALES				
FROM Occupational Level I:				
TO Level I (Retention)	0.50	0.50	0.50	0.50
Level II (Promotion)	0.15	0.15	0.15	0.15
Level III (Promotion)	0.05	0.05	0.05	0.05
Retirement	0.10	0.10	0.10	0.10
Termination	0.20	0.20	0.20	0.20
FROM Occupational Level II:				
TO Level I (Demotion)	0.10	0.10	0.10	0.10
Level II (Retention)	0.60	0.60	0.60	0.60
Level III (Promotion)	0.10	0.10	0.10	0.10
Retirement	0.10	0.10	0.10	0.10
Termination	0.10	0.10	0.10	0.10
FROM Occupational Level III:				
TO Level I (Demotion)	0.05	0.05	0.05	0.05
Level II (Demotion)	0.05	0.05	0.05	0.05
Level III (Retention)	0.70	0.70	0.70	0.70
Retirement	0.15	0.15	0.15	0.15
Termination	0.05	0.05	0.05	0.05
TRANSITION RATIOS:FEMALES				
FROM Occupational Level I:				
TO Level I (Retention)	0.50	0.50	0.50	0.50
Level II (Promotion)	0.15	0.15	0.15	0.15
Level III (Promotion)	0.05	0.05	0.05	0.05
Retirement	0.10	0.10	0.10	0.10
Termination	0.20	0.20	0.20	0.20
FROM Occupational Level II:				
TO Level I (Demotion)	0.10	0.10	0.10	0.10
Level II (Retention)	0.60	0.60	0.60	0.60
Level III (Promotion)	0.10	0.10	0.10	0.10
Retirement	0.10	0.10	0.10	0.10
Termination	0.10	0.10	0.10	0.10
FROM Occupational Level III:				
TO Level I (Demotion)	0.05	0.05	0.05	0.05
Level II (Demotion)	0.05	0.05	0.05	0.05
Level III (Retention)	0.70	0.70	0.70	0.70
Retirement	0.15	0.15	0.15	0.15
Termination	0.05	0.05	0.05	0.05

Table 1.4 Non-discriminatory Organization. Transition Ratios.

YEAR	1985	1986	1987	1988
NUMBER OF PROMOTIONS TO:				
Level I		0	0	0
		0	0	0
Level II		45	50	52
		15	17	17
Level III		30	33	35
		10	11	12
NUMBER OF DEMOTIONS TO:				
Level I		19	21	22
		6	7	7
Level II		4	4	4
		1	1	1
Level III		0	0	0
		0	0	0
EXTERNAL HIRES INTO:				
Level I Males		161	161	152
Females		54	54	51
Level II Males		26	21	13
Females		9	7	4
Level III Males		0	0	0
Females		0	0	0
NUMBER OF LAYOFFS FROM:				
Level I Males		0	0	0
Females		0	0	0
Level II Males		0	0	0
Females		0	0	0
Level III Males		0	4	9
Females		0	1	2
NUMBER OF RETIREMENTS FROM:				
Level I		30	33	35
		10	11	12
Level II		15	17	17
		5	6	6
Level III		12	13	13
		3	4	4
NUMBER OF TERMINATIONS FROM:				
Level I		60	66	69
		20	22	23
Level II		15	17	17
		5	6	6
Level III		4	4	4
		1	1	1

Table 1.5 Non-discriminatory Organization. Detailed Breakdown of Human Resource Movements.

INDEX FUNCTION		404,175	255,490	159,625
YEAR	1985	1986	1987	1988
TOTAL WORKFORCE (# persons)	700	770	809	809
GROWTH RATE OF WORKFORCE	10.00%	5.00%	0.00%	0.00%
BREAKDOWN:				
Occupational Level I Males	350	356	362	357
Females	50	84	100	105
Occupational Level II Males	175	190	193	188
Females	25	30	38	42
Occupational Level III Males	95	102	105	102
Females	5	8	11	13
Coefficients: Hires		1	1	1
Layoffs		1	1	1
EEO Males		100	100	100
EEO Females		100	100	100
Promotions		100	100	100
Demotions		100	100	100
	Labor Market Ratios			
EEO Goal Males I	0.75	330	347	347
II	0.75	165	173	173
III	0.80	88	93	93
EEO Goal Females I	0.25	110	116	116
II	0.25	55	58	58
III	0.20	22	23	23
Historical Promotions II		60	70	79
III		40	45	50
Historical Demotions I		25	25	26
II		5	5	5

Table 1.6 Discriminatory Organization. EEO Goals and Summary Screen in Example 1.

INDEX FUNCTION			434,441	275,438	176,180
YEAR		1985	1986	1987	1988
TOTAL WORKFORCE (# persons)		700	770	809	809
GROWTH RATE OF WORKFORCE		10.00%	5.00%	0.00%	0.00%
BREAKDOWN:					
Occupational Level I Males		350	359	367	364
Females		50	82	96	99
Occupational Level II Males		175	189	192	187
Females		25	31	41	46
Occupational Level III Males		95	100	100	95
Females		5	10	15	20
Coefficients: Hires			1	1	1
Layoffs			1	1	1
EEO Males			100	100	100
EEO Females			100	100	100
Promotions			100	100	100
Demotions			100	100	100
		Labor Market Ratios			
EEO Goal Males I		0.75	330	347	347
II		0.75	165	173	174
III		0.80	88	93	93
EEO Goal Females I		0.25	110	116	116
II		0.25	55	58	58
III		0.20	22	23	23
Historical Promotions II			60	72	82
III			40	47	52
Historical Demotions I			25	25	25
II			5	5	6

Table 1.7 Discriminatory Organization. EEO Goals and Summary Screen in Example 2.

INPUT INFORMATION:

Quota for Selection	100 successful managers
Assessor-to-Assessee Ratio	0.40 (1:1.5-1:2.5)
Number of Assessees	12 (9-15)
Criterion: Yearly Sales/manager	
Standard Deviation	$10,000
Average Tenure in Position	6 years
Stability of Performance	0.70 average year-to-year

CANDIDATES:	Estimate of Candidates Needed	Source of Candidates: Internal	External
SELECTION PROCEDURE:			
Traditional Selection	200	150	50
Assessment Center	200	150	50

Table 2.1 Required Input Information to the Model. Assessment Center Procedure Example.

COST INFORMATION:

Recruitment Costs: Internal	$200	
External	$400	
Induction Costs	$10	
Training Costs	$850	
Selection Costs: Traditional Procedure	$300	(interviews)
Assessment Center:Establish	$3,000	
Per Assessor	$400	
Per Assessee	$200	

SUMMARY OF COSTS:	Traditional Procedure	Assessment Center Procedure
Recruitment	$50,000	$50,000
Processing	$2,000	$2,000
Traditional Selection	$60,000	NA
Assessment Center	NA	$73,720
Training	$85,000	$85,000
TOTAL COST	$197,000	$210,720

Table 2.2 Relevant Cost Information. Assessment Center Procedure Example.

OUTPUT INFORMATION:

TRADITIONAL SELECTION PROCEDURE

Chosen
Selection Ratio: 0.50 (Values between .01 and .99; step .01)

Ordinate at Chosen Selection Ratio: 0.399

Chosen Validity: 0.20 (Values between .01 and .99; step .01)

Incremental Gain	Total Cost	Gain in Utility
\$829,306	\$197,000	\$632,306

ASSESSMENT CENTER PROCEDURE

Chosen
Selection Ratio: 0.50 (Values between .01 and .99 step .01)

Ordinate at Chosen Selection Ratio: 0.399

Chosen Validity: 0.40 (Values between .01 and .99; step .01)

Incremental Gain	Total Cost	Gain in Utility	Assessment Center Payoff
\$1,658,612	\$210,720	\$1,447,892	\$815,586
			Payoff Per Selectee
			\$8,156

Table 2.3 Selection Procedure Incremental Gain in Utility. Alternate Selection Procedure Payoff.

MAIN MENU	SECONDARY MENU	DESCRIPTION
ANALYSIS	COSTS	The input and cost analysis portion of the program, where a cost analysis of the database records is performed for each criterion defined by the user.
	STATISTICS	The statistical retrieval section, where database records can be selected through user-defined criteria and printed.
	DATABASE	The database containing records of all grievances with information on people involved, issues, and costs.
	UNSOLVED	The analysis of pending grievances section, where the policies and cost implications of possible solution packages to grievances pending are examined.
GRAPHICS	MONTH	Allows the creation of graphs of the number of grievances by month and of the costs of grievances by month.
	STEP	Allows the creation of graphs of the number of grievances by solution step and of the costs of the grievances by step.
	ISSUE	Allows the creation of graphs of the number of grievances by grievance issue and of the costs of grievances by issue.
	DEPARTMENT	Allows the creation of graphs of the number of grievances by department and of the costs of grievances by department.
PRINT	COSTS	Prints the input information and cost-analysis results.
	DATABASE	Prints the whole database.
	UNSOLVED	Prints the designed solution packages.
SAVE		Saves the current data and calculations of the program.

Table 3.1 Primary and Secondary Menus.

CRITERION:	DEPT	RESOLVED	SUPERVISOR	ISSUE FILED
=========	A	Pending	Kim	1 Nov-85

RELEVANT CASE INFORMATION:	STEP	TOTALCOST	GRIEVANTS
========================	0	$0	1

	PROB	SETTLEMENT	TIME (MINUTES)				
STEP	SOLUTION	COST	1	2	3	4	ARB
1	0.80	$950	60				
			30				
2	0.80	$900		60			
				30			
3	0.80	$850			60		
					30		
4	0.75	$800				60	
						30	
ARB		$750					30

PACKAGE #:	1		EXPECTED COST		$982.40
SETTLEMENT REACHED?	1	2	3	4	ARBITRATION
YES	$988	$962	$967	$908	$860
NO	$961	$954	$901	$880	NA
WORST COST	$988		BEST COST	$880	

Table 3.2 Alternate Solution Package. Grievance Filed November, 1985.

CRITERION:	DEPT	RESOLVED	SUPERVISOR	ISSUE FILED
==========	A	Pending	Kim	1 Nov-85

RELEVANT CASE INFORMATION:	STEP	TOTALCOST	GRIEVANTS
=========================	0	$0	1

STEP	PROB SOLUTION	SETTLEMENT COST	TIME (MINUTES) 1	2	3	4	ARB
1	0.60	$700	60				
			20				
2	0.70	$750		50			
				20			
3	0.80	$800			60		
					30		
4	0.90	$900				60	
						30	
ARB		$1,000					30

PACKAGE #: 2 EXPECTED COST $777.27

SETTLEMENT REACHED?	1	2	3	4	ARBITRATION
YES	$738	$799	$904	$994	$1,116
NO	$836	$924	$1,007	$1,116	NA

WORST COST $1,116 BEST COST $738

Table 3.3 Alternate Solution Package. Grievance Filed November, 1985.

COSTS OF GRIEVANCES
=================

INPUT INFORMATION [Use company-wide averages]

STEP 1	Grievant's Wage	$8.50
	Steward's Wage	$8.70
	Supervisor's Wage	$11.00
	Utility Person's Wage	$8.63
STEP 2	Plant Manager's Wage	$14.00
	Committee Person's Wage	$9.78
STEP 3	Dir. of I.R.'s Wage	$17.50
	Business Rep.'s Wage	$11.50
	Comm. Secretary Wage	$9.50
ARBITRATION	Arbitrator's Wage	$25.00

CRITERION:	DEPT	STEP	SUPERVISOR	ISSUE	FILED
					Oct-85

COSTS:
======

NUMBER OF CASES:	5
NUMBER OF GRIEVANTS INVOLVED:	14
AVG. GRIEVANTS PER CASE:	2.80

	STEP1	STEP2	STEP3	STEP4	ARBIT.
AVG. COST PER CASE:	$64.60	$12.61	$41.26	$14.50	$0.00

AVG. NEGOTIATION COST PER CASE:	$132.97
AVG. SETTLEMENT COST PER CASE:	$341.40
TOTAL SETTLEMENT COSTS:	$1,707
TOTAL COSTS OF GRIEVANCES:	$2,372

Table 3.4 Input and Cost Information for a Given Criterion.

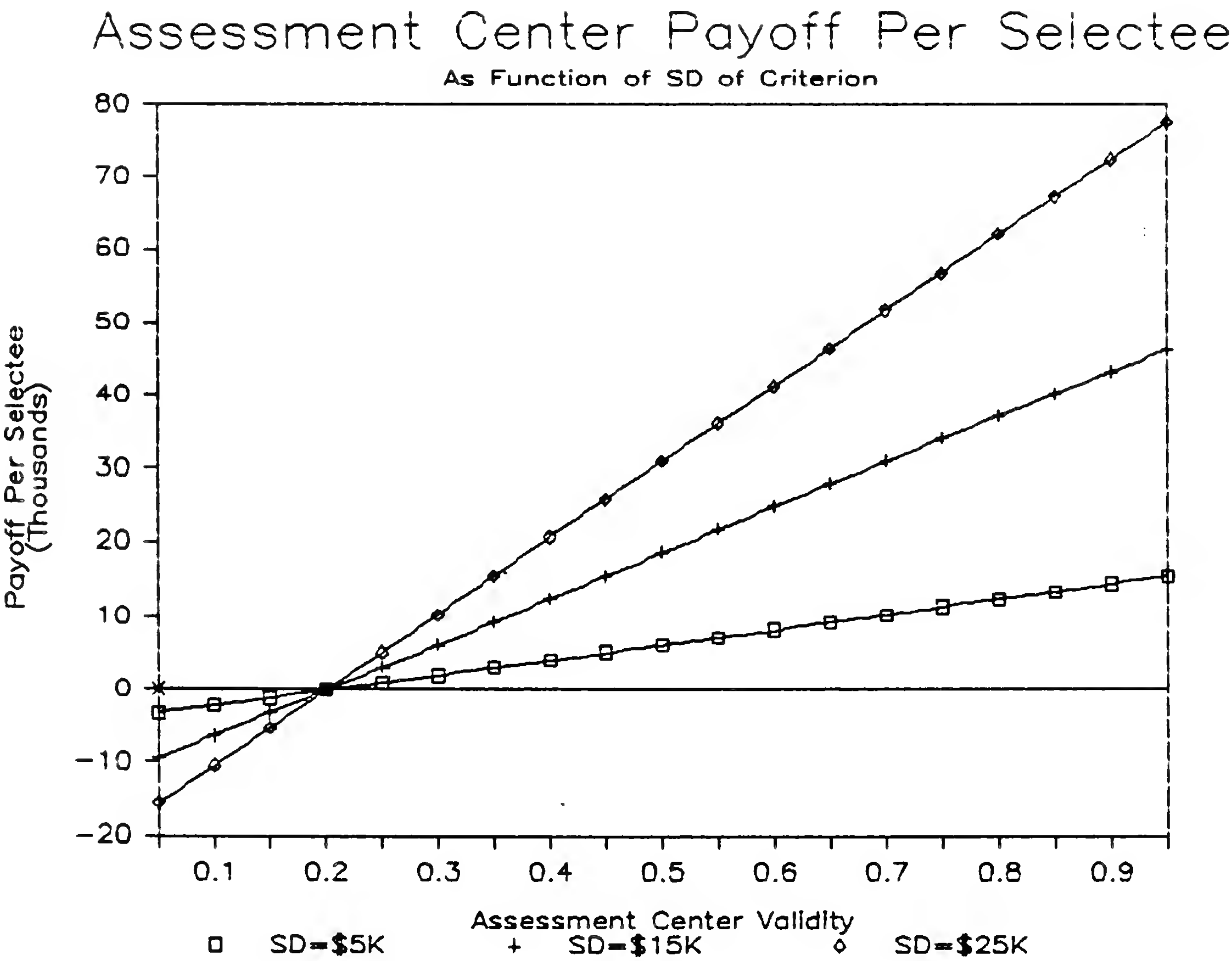

Figure 2.1 Assessment Center Payoff per Selectee vs. Validity.

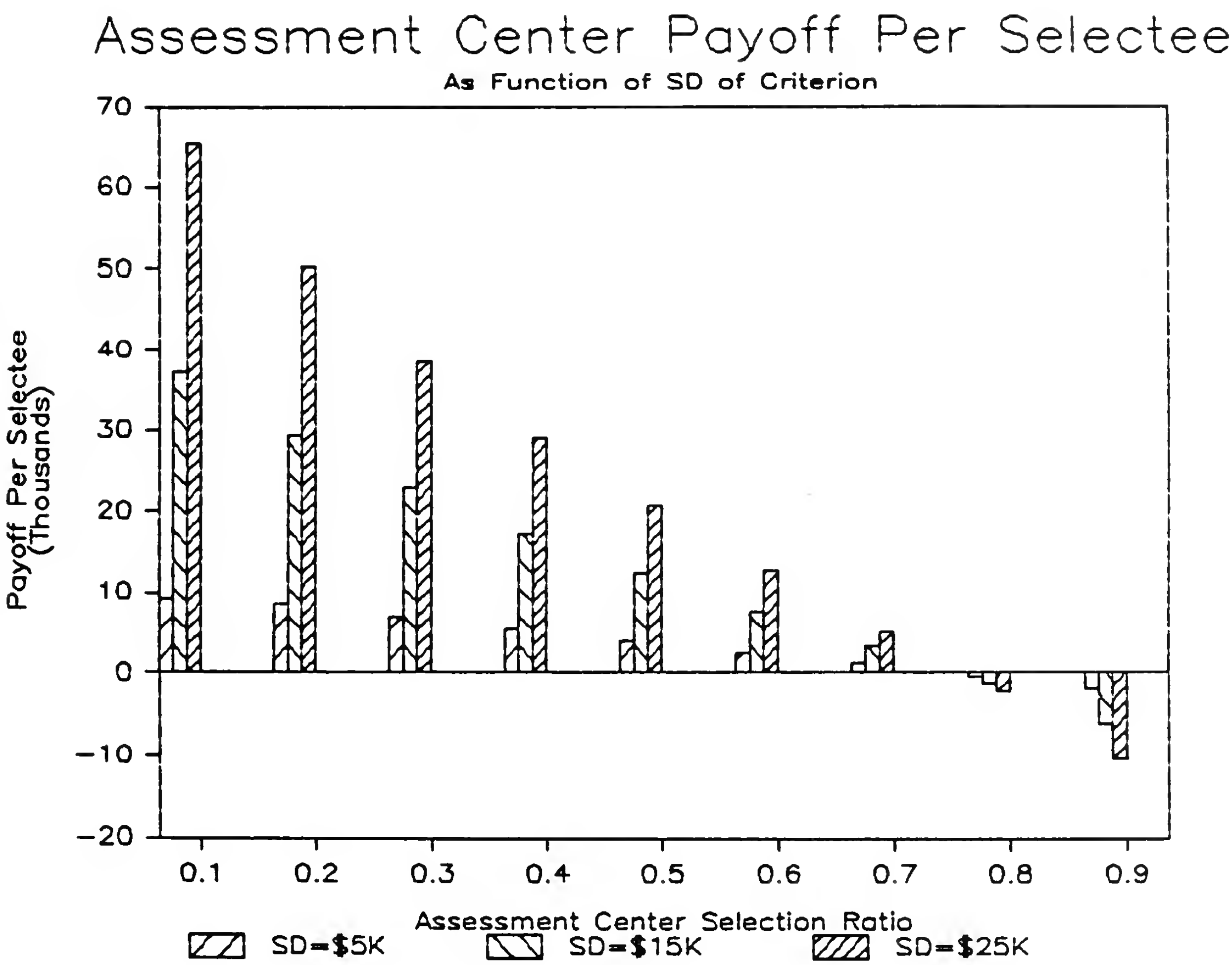

Figure 2.2 Assessment Center Payoff per Selectee vs. Selection Ratio.

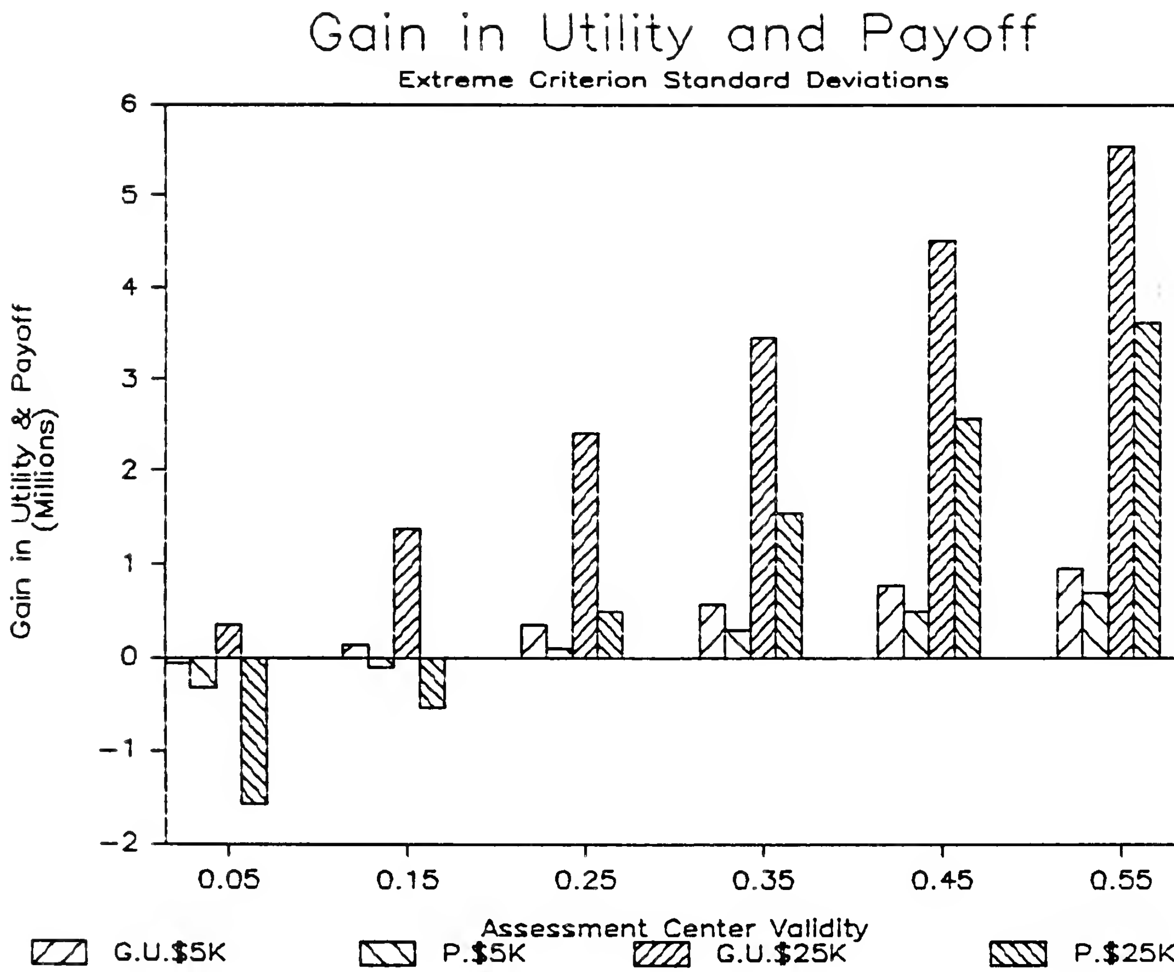

Figure 2.3 Assessment Center Gain in Utility and Payoff vs. Assessment Center Validity.

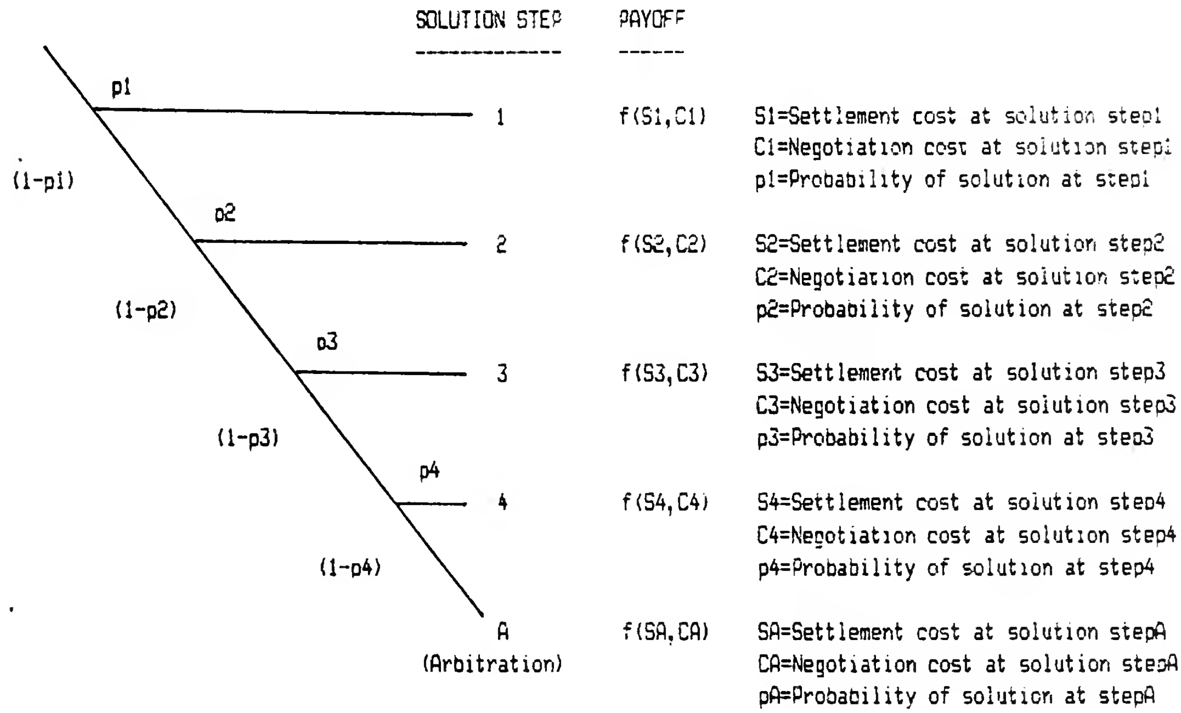

Figure 3.1 Tree Structure for the Estimation of Expected Costs of Grievance Settlement.

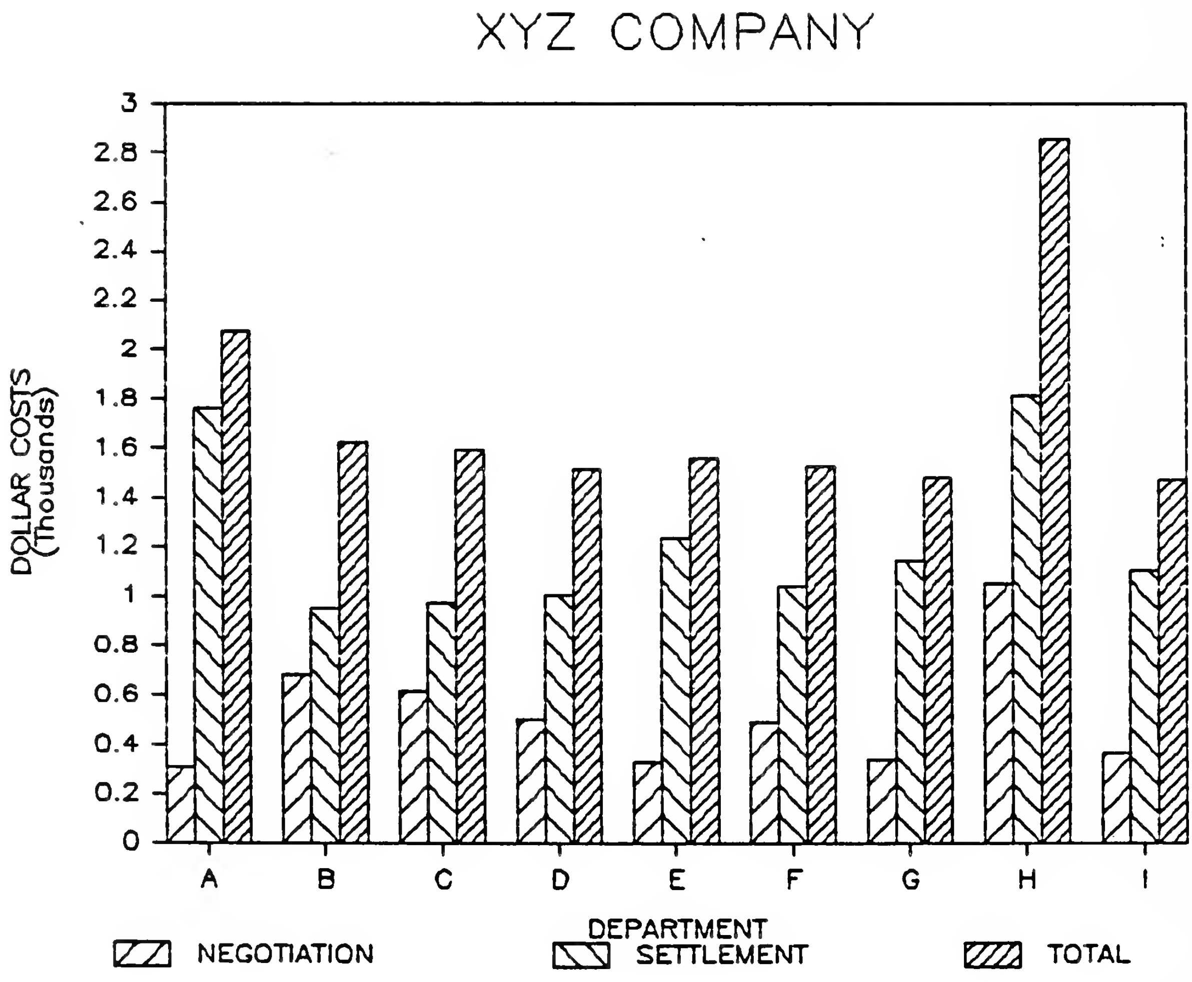

Figure 3.2 Dollar Costs of Grievances per Department

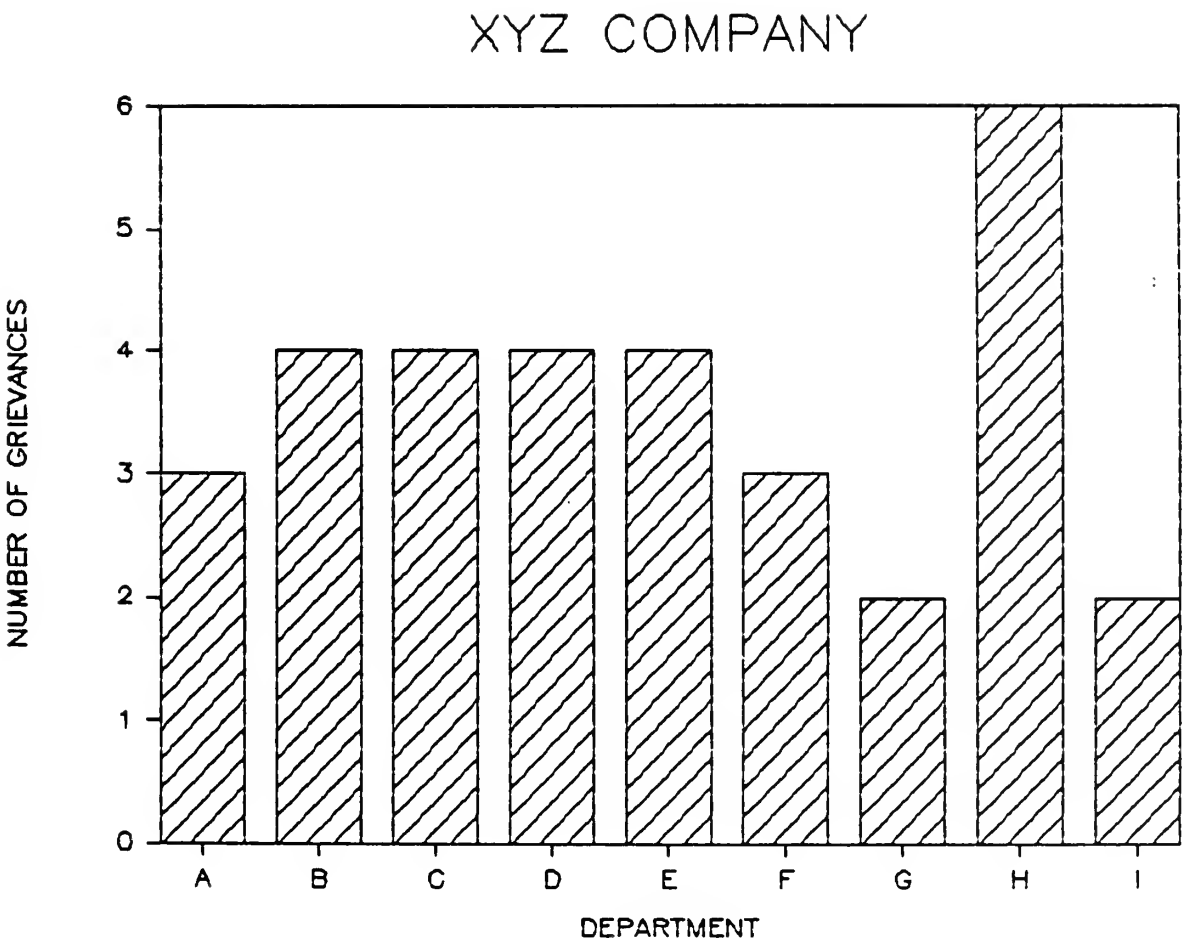

Figure 3.3 Number of Grievances per Department.